aibn Accident Investigation Board Norway

**Issued February 2019**

# REPORT SL 2019/01

# REPORT ON AIR ACCIDENT IN PORT OF BERGEN, HORDALAND COUNTY, NORWAY, 10 MAY 2017 INVOLVING AIRBUS HELICOPTERS AS 350 B3, G-HKCN



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*This report has been translated into English and published by the AIBN to facilitate access by international readers.*
*As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.*

**Photos: AIBN and Trond Isaksen/OSL**

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## REPORT ON AIR ACCIDENT

| | |
|---|---|
| Type of aircraft: | Airbus Helicopters AS 350 B3 |
| Nationality and registration: | British, G-HKCN |
| Owner: | Private |
| Operator: | Private |
| Crew/commander: | 2[1] |
| Passengers: | 1 |
| Accident site: | Port of Bergen |
| Accident time: | Wednesday 10 May 2017 at 2124 hrs |

All times given in this report are local time (UTC + 2 hours) unless otherwise stated.

## ACCIDENT NOTIFICATION

On 10 May at 2206 hrs, the Accident Investigation Board's on-duty officer was notified by the Joint Rescue Coordination Centre South Norway of a helicopter accident. An AS 350 B3 with registration G-HKCN had ended up in the sea behind a yacht in the Port of Bergen. All three people on board had exited the helicopter. One of the passengers required life-saving aid and was transported to hospital.

AIBN travelled to the accident site the day after with two accident inspectors, and commenced the investigation work. In accordance with ICAO Annex 13, "Aircraft Accident and Incident Investigation", AIBN notified the investigation authorities in France, which is the manufacturing country, and in the UK, where the helicopter was registered. AIBN's UK counterpart (AAIB) appointed an accredited representative and two advisers who all three assisted in the investigation.

## SUMMARY

On the evening of Wednesday, 10 May 2017, the helicopter G-HKCN flew from Bergen airport (ENBR) to the yacht M/Y Bacarella, which was located in the Port of Bergen. There were two others on board in addition to the commander.

When the helicopter had established a low hover over the yacht's helideck, a tarpaulin that covered a jet fuel bowser blew up into the helicopter's main rotor. The pilot lost control of the helicopter, and it crashed into the sea tail first and tipped over to the right. It remained floating upside-down.

The commander, seated in the left hand seat, was able to quickly evacuate through the left door. Having exited the helicopter, he realised that the helicopter would sink and dived into the cockpit where he was able to activate the switch to inflate the floats. The passenger in the rear seat was able to evacuate without assistance. The commander dived into the helicopter once more and assisted the

[1] The pilot flying the helicopter did not have type rating on AS 350 B3.

pilot in the right hand seat to evacuate.It was this person that piloted the helicopter when the tarpaulin hit the main rotor. All three made their way up on the belly of the floating helicopter.

The Norwegian Society for Sea Rescue[2] had a boat on assignment in the immediate vicinity. They arrived at the accident site approximately two minutes after the accident, and initiated life-saving efforts on the passenger who lost consciousness after he had managed to climb on to the helicopter's belly.

The helicopter was equipped with a video recorder of the type Appareo 1000. This unit recorded a video of the incident, which has been greatly beneficial in the investigation. The yacht's CCTV recording of the helideck at the time of the accident has also been useful for the investigation.

The AIBN has not discovered any technical errors or irregularities in the helicopter that may have influenced the course of events during this accident.

# 1. FACTUAL INFORMATION

## 1.1 History of the flight

1.1.1 The helicopter

1.1.1.1 On 10 May 2017, G-HKCN, a privately owned Airbus Helicopters AS 350 B3, flew from Denham near London to Bergen, where the yacht M/Y Bacarella was at port. The objective of the flight was to have the helicopter on board the yacht to use for sightseeing on a cruise along the coast of Norway. There were three people on board the helicopter.

1.1.1.2 The commander had valid type rating and instructor rating for the helicopter type. He was in the left hand seat. The pilot in the right hand seat did not have valid ratings for the helicopter type. He had however a valid Private Pilot Licence PPL(H) for helicopters with type rating on Robinson 44 and Robinson 66. The flight and the planned cruise along the Norwegian coast was of a private nature.

1.1.1.3 There were several items of unsecured luggage in the cabin, since there was insufficient storage capacity in the luggage compartments.

1.1.1.4 They flew north through England and Scotland with a stop in Oban, Scotland, where they had lunch. Then continued to Sumburgh on Shetland and refuelled the helicopter, got dressed in survival suits and prepared a life raft they had brought for the flight over the North Sea to Bergen airport (ENBR). The helicopter was equipped with emergency flotation gear.

1.1.1.5 The helicopter landed at Bergen Airport for refuelling. Here all three on board took off their survival suits and life jackets.

1.1.1.6 From Bergen airport, the helicopter headed directly to M/Y Bacarella. The yacht was ordered by the port authority to leave the quay to receive the helicopter. The pilot in the right seat flew the helicopter from Bergen airport. The helicopter took off at

[2] The Norwegian Society for Sea Rescue is a humanitarian organisation whose purpose is to save lives at sea, rescue and protect assets at sea and carry out preventive work to improve the safety of those to travel at sea. The Norwegian Society for Sea Rescue has 54 operative rescue vessels serving 59 stations along the coast.

approximately 1915 hrs, with the intention of landing on the yacht's helideck. The commander monitored the controls hands on during the landing phase.

1.1.1.7 As the helicopter approached the helideck on the yacht, it stopped in low hover over the helideck for approximately 15 seconds[3], until a tarpaulin covering a jet fuel bowser located forward on the helideck detached and was blown up in the main rotor. The commander grabbed the controls and attempted to manoeuvre the helicopter aft and to the left to avoid the tarpaulin, which was on its way to blow into the main rotor due to the rotor downdraft. He did not have time to make a difference before the tarpaulin caused considerable damage to the main rotor when it encountered the rotor blades and was ripped to shreds (see Figure 1).


*Figure 1: The helicopter as the tarpaulin hit the main rotor. Photo: CCTV M/Y Bacarella*

1.1.1.8 The damages to the main rotor caused significant vibrations in the helicopter. This can be observed on the video recording from the Appareo 1000 unit. The commander lost control of the helicopter after the tarpaulin struck the main rotor.

1.1.1.9 During this phase, both the commander and the pilot in the right hand seat had their hands on the controls. The helicopter ended up in the sea somewhat aft and port (left hand side) of the yacht with tail first and quickly tilted over to the right, before it came to rest upside-down (see Figure 2).

1.1.1.10 While both persons in the front seats were buckled up, the passenger in the aft seat was not. Recording from the Appareo 1000 shows that the passenger is thrown forward over the pedestal and the right hand collective.

[3] Timing is taken from the helicopters Appareo 1000 video camera recording.

*Figure 2: The helicopter crashed tail first. Photo: CCTV M/Y Bacarella*

1.1.1.11 The commander was able to evacuate through the left door, but realised that the helicopter was sinking, as the floats did not inflate. The floats were armed as they passed the coastline on their way out to the Port of Bergen. The emergency floatation gear on AS 350 helicopters do not inflate automatically. He dived into the helicopter and managed to activate the switch on the right hand collective to inflate the floats. Thereby he prevented the helicopter from sinking (see Figure 3).

*Figure 3: The helicopter remained floating upside-down due to the inflated floats. Photo: CCTV M/Y Bacarella*

1.1.1.12 The passenger in the aft seat was able to evacuate on his own. The commander dived down again and assisted the pilot in the front seat in evacuating.

1.1.1.13 Several boats arrived shortly after the accident. This included one of the Norwegian Society for Sea Rescue's boats. They were in the process of towing a boat to quay when they saw what happened. They cast off from the boat, and were at the accident site approximately two minutes after the helicopter had crashed. The three persons who were in the helicopter had all climbed on to the belly of the floating helicopter.

1.1.1.14 When the Norwegian Society for Sea Rescue's boat arrived at the accident site, the passenger who had been in the aft seat lost consciousness. It is presumed that he had inhaled a mixture of seawater and jet fuel and/or oil. He was immediately taken on board the Norwegian Society for Sea Rescue's boat, and cardiopulmonary resuscitation (CPR) was initiated while an ambulance and medical assistance were requested over channel 16 on maritime VHF. When the boat arrived at the quay, the police were present and CPR was continued on the quay until the ambulance and physician arrived. He was transported to hospital and was unconscious in intensive care for several days.

1.1.2 M/Y Bacarella

1.1.2.1 M/Y Bacarella came from Falmouth, England, directly to Bergen the day before the accident to await the helicopter to arrive. They loaded on board a jet fuel bowser which was intended to be used to refuel the helicopter during the cruise along the Norwegian coast. A custom made tarpaulin was fabricated in Bergen on the yacht’s request. It was designed to fit tightly over the frame on the bowser. The unit was covered with this tarpaulin.

1.1.2.2 On the day of the accident, the yacht was not allowed by the port authorities to receive the helicopter at quay, and therefore positioned itself in the harbour without anchoring. Wind speed was 3-4 knots and the sea was calm. The master on M/Y Bacarella felt pressed for time to prepare for the arrival of the helicopter. The yacht’s Helicopter Operations Manual procedures required preparation of the fire extinguishing equipment for helicopter operations, and to launch a tender for safety. Due to an impression of lacking time this was not done.

1.1.2.3 According to the master's explanation, he monitored the landing from the bridge with the aid of a surveillance camera (CCTV). The first mate was new on board the yacht, and this was his first helideck operation. He was supposed to act as "Helideck Landing Officer" (HLO). The first mate was standing inside glass doors forward of the helideck to monitor the landing. Both the master and the first mate communicated with the helicopter. The first mate notified the master that everything was ready, and the master cleared the helicopter for landing.

1.1.2.4 The first mate was new on the yacht the day before the accident, and stated he had received a superficial brief on helicopter operations by the former first mate without any reference to the yacht’s Helicopter Operations Manual.

1.1.2.5 The custom made tarpaulin covering the jet fuel bowser was not lashed down using the affixed eyelets. The tarpaulin’s fit around the fuel bowser’s frame was so tight that lashing was considered necessary only in windy conditions and when in open waters. The cruise was to be in coastal waters.

1.1.2.6 The yacht’s CCTV video recording covering the helideck and the video file from the Appareo 1000 recording in the helicopter showed that the helicopter established a low

hover above the helideck which lasted for approximately 15 seconds, until the tarpaulin blew off the fuel bowser.

1.1.2.7 From when the tarpaulin blew off the fuel bowser, the sequence of events was so rapid that the first mate only was able to take cover. The master did not observe that the tarpaulin had blown up into the main rotor, he believed the helicopter had struck one of the antenna radomes on the yacht.

## 1.2 Injuries to persons

*Table 1: Personal injuries*

| Injuries | Crew | Passengers | Others |
|---|---|---|---|
| Fatalities | | | |
| Severe | | 1 | |
| Minor/none | 2* | | |

*The pilot sitting in the right hand seat did not have a valid type rating for the helicopter type.

## 1.3 Damage to aircraft

The helicopter sustained major damages to the main rotor system when the fuel bowser's tarpaulin cover hit the main rotor. The crash further damaged the helicopter. It came to rest floating upside-down in the water. The tailboom broke, and the main rotor hub with blades and the attachment of the main gearbox to the airframe sustained significant damage. See also section 1.12.

## 1.4 Other damage

None

## 1.5 Personnel information

1.5.1 The commander, age 52, had an Airline Transport Pilot License for helicopters (ATPL (H)). He also had an instructor rating for AS 350 B3.

*Table 2: Flying hours commander*

| Flying hours | All types | Relevant type |
|---|---|---|
| Last 24 hours | 8 | 8 |
| Last 3 days | 10.6 | 8 |
| Last 30 days | 49.1 | 14.8 |
| Last 90 days | 105.8 | 43.9 |
| Total | >15 000 | >400 |

1.5.2 The pilot in the right front seat had a Private Pilot's License for helicopters (PPL(H)) and type ratings on Robinson R44 and Robinson R66 helicopters. He had also completed type training and a skill test on the AS 350 B3 helicopter. The skill test was completed the day before the accident. The UK CAA had yet to issue the licence. His total experience on helicopters was 290.6 flight hours. Of these, 16.4 flight hours were on AS 350 B3.

## 1.6 Aircraft information

1.6.1 The helicopter was an Airbus Helicopters AS 350 B3. The helicopter has an engine of the type Safran Helicopter Engines Arriel 2D. The helicopter's total length is 12.94 m, including the main rotor. The main rotor diameter is 10.69 m.

- Registration: G-HKCN
- Serial number: 8219
- Construction year: 2016
- Date of last inspection: 28 April 2017
- Flight hours since last inspection: Annual inspection 89.7 flt hours
- Total flight hours: 99.7 hours[4]
- Maximum allowed take-off mass: 2 250 kg
- Estimated mass at time of accident: approximately 2 087 kg[5]
- Centre of gravity at time of accident: Within permitted limits

## 1.7 Meteorological information

The METAR for Bergen airport at 21:20 (local time) stated the following:

ENBR 101920Z 26005KT 9999 FEW020CB BKN028 07/02 Q1002 NOSIG

## 1.8 Aids to navigation

Not appplicable.

## 1.9 Communications

The helicopter had ordinary VHF communication with the air traffic service at Bergen airport.

There was radio and phone communication between the helicopter and M/Y Bacarella.

## 1.10 Aerodrome information

1.10.1.1 M/Y Bacarella had a helideck designed with foldable railings, pennant pole and aft lantern. The yacht’s Helicopter Operations Manual did not refer to the actual AS 350 helicopter type, it only referred to operations with Robinson R44 and R66 helicopters.

1.10.1.2 The AS 350 B3 has approximately twice the empty weight compared to R44 and R66 helicopters.

[4] Logging last took place 9 May 2017
[5] The helicopter's empty weight at weight control carried out 14 November 2016 was 1 414.14 kg.

1.10.1.3 The yacht was not originally equipped with a fuel bowser for refuelling of helicopters. During the planned trip along the Norwegian coast, the intention was to use the helicopter for sightseeing from the yacht. For this purpose, a fuel bowser with a capacity of approximately 900 litres was placed on the helideck (see figure 4).

*Figure 4: Helideck on M/Y Bacarella with provisional jet fuel bowser. Photo: Bergensavisen newspaper*

1.10.1.4 Refuelling of helicopters on board was not described in the yacht's Helicopter Operations Manual.

1.10.1.5 The helideck on M/Y Bacarella was designed to have the opportunity to land and take off without stopping the helicopters engine. The helideck had a marked circular area which the helicopter should land within. The helicopter's tail section would then stick out aft of the helideck (see figure 5). The purpose of the marked circle was to indicate a landing zone which gave safe distance between the helicopter's main rotor and structures on the yacht. The intention was to operate G-HKCN from M/Y Bacarella on this 10-day cruise.

*Figure 5: Aft part of helideck landing zone marked in red. Photo: The police. Illustration: AIBN*

1.10.1.6 The master only accepted operating the helicopter from the yacht's helideck in coastal waters.

1.10.1.7 It was decided to make a tarpaulin prepared to cover the fuel bowser. The tarpaulin was produced in 680g/$m^2$ PVC-coated polyester cloth and was sewn according to specification given by the yacht's crew. Eyelets were affixed to make it possible to lash the tarpaulin to the fuel bowser. The tarpaulin had a tight fit over the bowser's frame and was not lashed down when accident occurred.

1.10.1.8 The bulkheads in front, and partially on the sides of the helideck where the fuel bowser was placed, had a design that prevented the rotor downdraft from escaping in front of the helicopter. The Appareo 1000 video recording shows that the tarpaulin was inflated by the pulsating rotor blade downwash pressure from the hovering helicopter. The hover lasted for approximately 15 seconds. This pulsating pressure caused the tight fitting tarpaulin to "creep" upward on the bowser's steel frame until it suddenly took off and was sucked downwards through the main rotor disc (see figure 6). The helicopter's weight created a significantly larger downdraft effect than a R44 or R66 would have done.

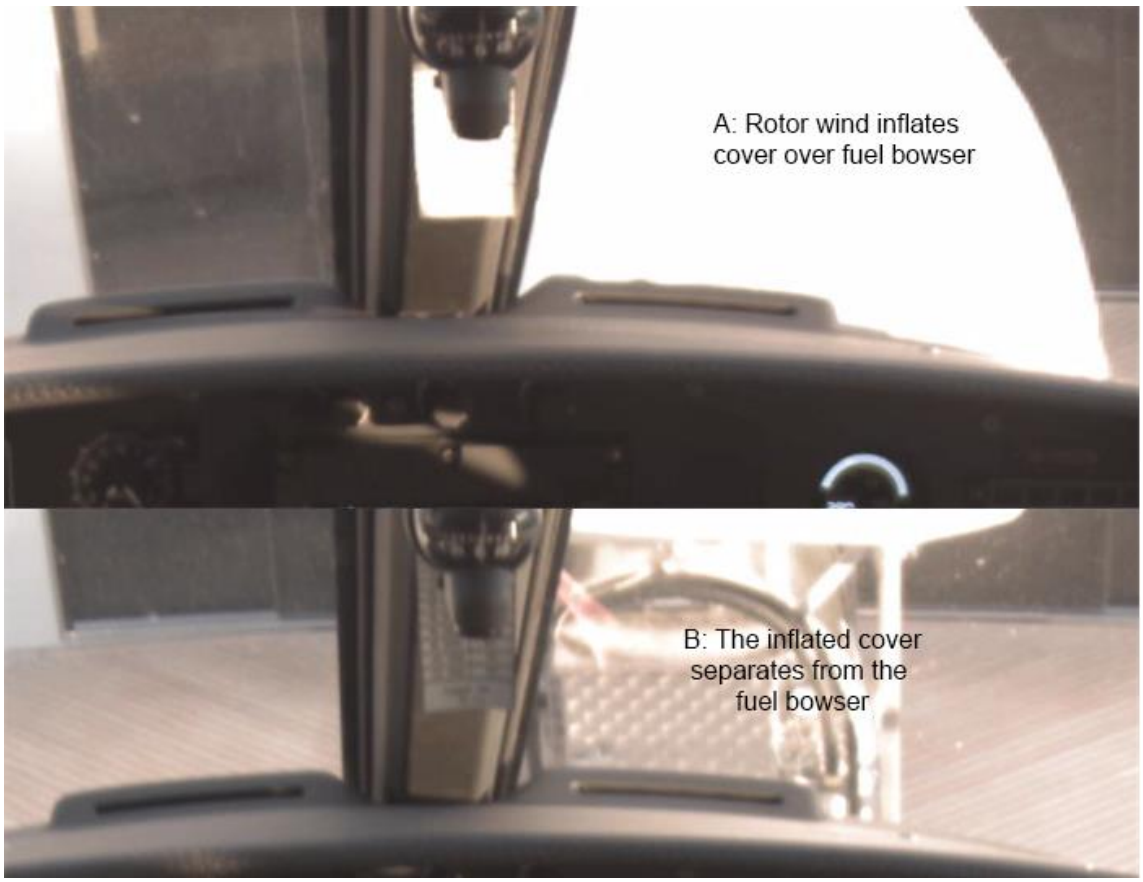


*Figure 6: Sequence of photos showing the tarpaulin as it leaves the jet fuel bowser. Photo: The helicopter's Appareo 1000 camera*

## 1.11 Flight recorders

1.11.1 The helicopter was equipped with an Appareo 1000 video recorder. Video from this unit was beneficial in AIBN's investigation of the accident. The recorder continued to record also when submerged.

1.11.2 The engine was equipped with an engine data recorder (EDR). The data from this unit was analysed by AIBN's French counterpart (BEA)[6] and SAFRAN Helicopter Engines.

## 1.12 Wreckage and impact information

1.12.1 The crash site

1.12.1.1 The crash occurred in northern Byfjorden, approximately 1.5 km north of Skoltegrunn quay. Water depth in this area is approximately 200 m.

1.12.2 The helicopter wreckage

The helicopter was severely damaged. The main rotor sustained damages when the tarpaulin impacted the leading edge one of the main rotor blades. Further, when the helicopter impacted the water surface, tail first, the tailboom was nearly broken off. The

[6] Bureau d'Enquetes et d'Analyses pour la Sècuritè de l'Aviation Civile

main rotor was further damaged when the rotor blades impacted the water. Due to the impact, the main gearbox shifted to the right (see Figure 7).

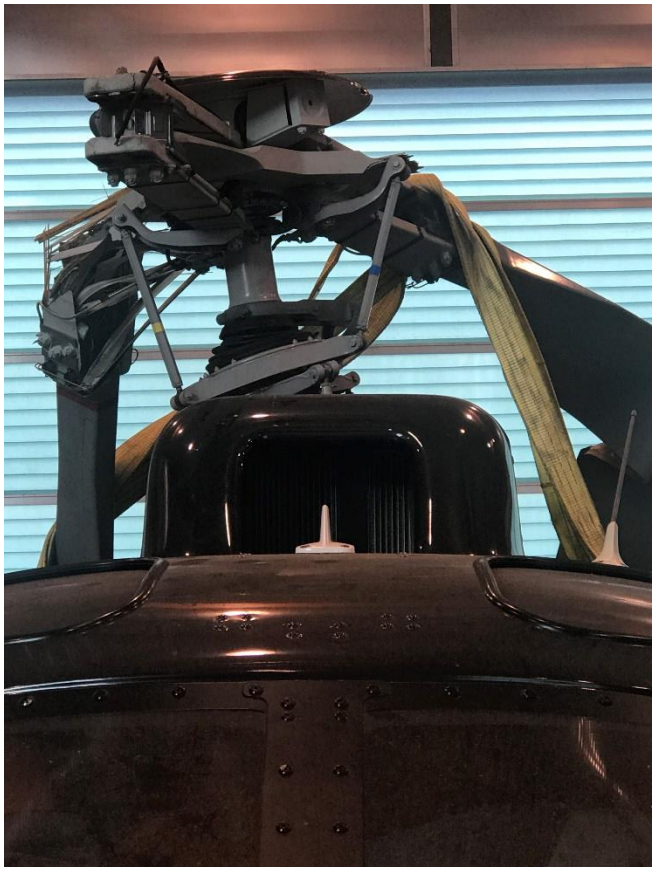

*Figure 7: Main gearbox displacement. Photo: AIBN*

The two right hand side main gearbox suspension bars broke off. The two on the left hand side were bent (see Figure 8).

*Figure 8: Forward and aft right hand MGB suspension bars. Photo: AIBN*

1.12.2.1 The cabin and survival space for the three people on board was not damaged in such a way that it affected the passengers.

1.12.2.2 The damages on the helicopter were a result of the tarpaulin that hit the main rotor, and the following impact with the water surface. The investigation did not reveal any technical issues that could influence on the manoeuvring characteristics of the helicopter before the accident.

1.12.2.3 Analysis of data from the Engine Data Recorder (EDR) showed that the engine functioned as intended. Thus, a malfunction of the engine is not a factor in this accident.

## 1.13 Medical and pathological information

The commander was subject to routine testing. No traces of alcohol or other substances were found in the samples.

## 1.14 Fire

Not applicable.

## 1.15 Survival aspects

1.15.1 The accident occurred in the Port of Bergen. One of the Norwegian Society for Sea Rescue's boats was in the vicinity. It was towing a boat with engine failure. They cast off the tow and were at the accident site to assist in the rescue in the course of a couple of minutes. They got all three who had been in the helicopter on board, and life-saving efforts were initiated for the passenger who had lost consciousness. This person remained unconscious for several days after the accident.

1.15.2 The aft seat was equipped with three-point seat belts, but the passenger was not using one. He was busy filming the approach on his mobile phone. As the fuel bowser’s tarpaulin hit the main rotor, the helicopter started to vibrate excessively. Just before the helicopter hit the water, he was thrown sideways, then forward and over the pedestal and the right hand collective stick.

1.15.3 There were multiple items of unsecured luggage in the cabin. In addition, there were multiple electronic devices with unsecured charging cables connected to power outlets.

1.15.4 Nobody on board the helicopter were using life jackets during the flight from Bergen airport to M/Y Bacarella.

1.15.5 The helicopter's "Emergency Flotation Gear" was armed during flight, and was activated by the commander after the helicopter had impacted the water surface and the helicopter cabin was submerged.

## 1.16 Tests and research

Not applicable.

## 1.17 Organizational and management information

1.17.1 The helicopter

1.17.1.1 According to the UK CAA's register, the helicopter was owned by HQ Aviation. HQ Aviation was a "Registered Training Facility" (RTF). G-HKCN was not used in the RTF organisation and was only intended for private use. As a result, it was subject to the rules for private flights.

1.17.1.2 The helicopter was maintained by Airbus Helicopters UK. (CAA Approval number UK.145.00124).

1.17.2 M/Y Bacarella

1.17.2.1 M/Y Bacarella is a 59.7 m long yacht, built in 2009 and registered on the Cayman Islands. It is owned by Sun Vessel Global Ltd.

*Figure 9: M/Y Bacarella; the upper aft deck was used as a helideck. Source: YachtCharterfleet.com*

1.17.2.2 The yacht was classed by the American Bureau of Shipping (ABS) and built in accordance with "✠A1, Commercial Yachting Service, AMS" and the UK Maritime and Coastguard Agency's (MCA) "Large Yacht Code" (LYC 2). However, in February 2011, the owner at that time decided to change the classification to "✠A1, Yachting Service, AMS", because the yacht was not going to be used in commercial operations. Sun Vessel Global Ltd took ownership in the yacht in 2014. This entailed that there was no longer a requirement to have a certified helicopter landing area (HLA) or a safety management system in accordance with the ISM Code (International Safety Management Code).

1.17.2.3 The Cayman Islands maritime authority has no requirements for certification of recreational vessels that are in non-commercial operations; neither are there any equivalent international requirements. However, the yacht was classified in ABS, which

e.g. entailed an annual inspection of the hull and machinery, as well as an expanded five-year inspection. The yacht was also subject to two dry dock inspections during each five-year period. In addition to the inspections carried out pursuant to requirements for this class of vessels, M/Y Bacarella was subject to an annual safety inspection in order to satisfy the USCG's (United States Coast Guard) safety requirements for "foreign recreational vessels" that visit US waters. However, none of these inspections cover helicopter operations on board.

1.17.2.4 If the yacht had been in commercial operation, it would have been subject to certification in accordance with Annex 6 of the Large Yacht Code or CAP 437 (Standards for offshore helicopter landing areas, Civil Aviation Authority UK). Annex 6 only covers the technical aspects of the landing area, and the operational circumstances would have been under the requirements for ISM certification.

1.17.2.5 In spite of the fact that it was not required from any authority, M/Y Bacarella nevertheless had a Helicopter Operations Manual on board. The procedures laid down in this manual to prepare for helicopter landings were not adhered to on the day of the accident. The newly employed first mate was not properly trained or briefed on the tasks and responsibilities in the role as HLO. The manual's check list for preparing for helicopter operations says the following about loose items on the helideck:

> *Any loose items in the vicinity of the helideck must be secured immediately or reported to the HLO.*

1.17.2.6 The yacht's master explained that he felt pressed for time to prepare the ship for the helicopter landing. He accepted to rush the preparation. As a result, several issues in the Helicopter Operations Manual were omitted. The fire fighting equipment was not prepared for use on the helideck, and a safety tender was not set out.

### 1.18 Additional information

Not applicable.

### 1.19 Useful or effective investigation techniques

Not applicable.

# 2. ANALYSIS

### 2.1 Introduction

The direct cause of this accident, was that the tarpaulin covering the jet fuel bowser on board M/Y Bacarella blew through the helicopter's main rotor disc, and caused damage that made the helicopter become uncontrollable. Multiple factors contributed to this accident occurring. The analysis below will elucidate these factors.

### 2.2 Operational issues

2.2.1 The commander, who also had flight instructor privileges allowed a pilot with little experience on the helicopter type fly the helicopter in over the yacht's helideck with the intention to land from the right hand seat. The pilot had ratings on other helicopter types,

and a total flight experience of 290.4 flight hours. 16.4 of these flight hours were on AS 350 B3 in conjunction with training on type and skill test. The skill test was completed and passed the day before the accident.

2.2.2 The yacht's helideck was marginally sized, and the helicopter's tailboom would have to stick out aft of the helideck when it had landed. This required precise manoeuvring of the helicopter. In addition, due to the aerodynamic conditions (ground effect) created by the design and size of the helideck, the helicopter behaved differently than it would when landing on a larger landing surface. These circumstances, combined with the flying pilot's low experience on the AS 350 B3, resulted in a low hover over the helideck that lasted for approximately 15 seconds. This caused the main rotor's pulsating downdraft to make the tight fitting, but unsecured tarpaulin to "creep" upwards on the fuel bowser's frame, and finally blow up from the bowser and through the main rotor disc.

2.2.3 The commander, who sat in the left hand seat, was continuously monitoring the controls, but did not have time to react sufficiently when the tarpaulin blew up. In a situation where he, in addition to monitoring the controls, also had to continuously consider the necessity of taking over control of the helicopter may have contributed to allowing the other pilot trying longer than necessary to set the helicopter down within the designated landing zone on the helideck. The duration of the hover, and the main rotor downdraft from a helicopter that was considerably heavier than the helicopter types described in the yacht's Helicopter Operations Manual contributed to the tarpaulin blowing off the fuel bowser.

2.2.4 The fuel bowser that was located forward of the helideck landing zone was new, both for the commander of the helicopter, and for the yacht's crew. Despite this, the commander decided to allow the user of the yacht with his limited experience on the helicopter type to perform the approach to the helideck and to attempt to land the helicopter. This indicates that the commander's risk assessment beforehand did not take into consideration these two factors. AIBN is of the opinion that a proper risk assessment would most likely have resulted in the commander performing the landing himself. This would probably have shortened the time in hover and reduced the risk of the tarpaulin blowing off the fuel bowser.

2.2.5 There was no handover of helicopter control when the commander identified the danger. This resulted in both pilots having their hands on the controls when the tarpaulin lifted off the fuel bowser, and the commander tried to manoeuvre the helicopter away from the danger. This may have had influence on the intended control inputs given by the commander.

2.2.6 The passenger in the aft seat was not buckled up when the accident happened. The Appareo 1000 video file shows that due to the movements of the helicopter and just before the helicopter impacted the water surface, he was thrown forward between the front seats in such a manner that he probably made contact with the right collective stick. This may have affected its position and/or hindered its free movement. In addition, the risk of injury was substantially greater than if one was strapped in. It might be argued that in this case it eased his evacuation, but the actual negative effects not being strapped in are much greater.

2.2.7 There were multiple items of unsecured luggage in the helicopter's cabin. Multiple electronic devices with loose charging cords had also been brought along. Loose objects

in the cabin, such as in this case can complicate an evacuation, especially when the helicopter was inverted and the cabin was submerged. The risk of being hindered or disoriented during such a situation is significant. Loose items might also hit and injure persons on board, and make them unable to evacuate without assistance.

2.2.8 AIBN believes that the commander made extraordinary efforts to save lives once the accident had occurred. First by diving down to activate the emergency floatation gear switch, which prevented the helicopter from sinking, and then diving down a second time to retrieve the person who was unable to evacuate on his own.

## 2.3 Damages to the helicopter

AIBN believes that the damages to the helicopter were sustained in two phases

2.3.1 Phase 1: When the tarpaulin hit the main rotor, the rotor was damaged in such a manner that significant vibrations occurred. These vibrations could be observed on the Appareo 1000 video recording, where the imagery suddenly became blurry. Such damages are known from other accidents as a result of plastic sheets, tarpaulins or bulk cargo bags being blown through the rotor disc and thereby hitting the leading edge of a rotor blade[7]. The Starflex (main rotor composite hub) arms are vulnerable for impact shocks caused by materials hitting the attached rotor blade. In other accidents of similar nature, Starflex arms have broken off. A broken Starflex arm will allow large lead/lag movements of the blade since the frequency adapter no longer is attached to the Starflex main rotor hub. The consequence will be a major imbalance in the rotor disc and this will generate heavy vibrations. Loss of control of the helicopter is the most probable outcome of such damages to the Starflex (see Figure 10).

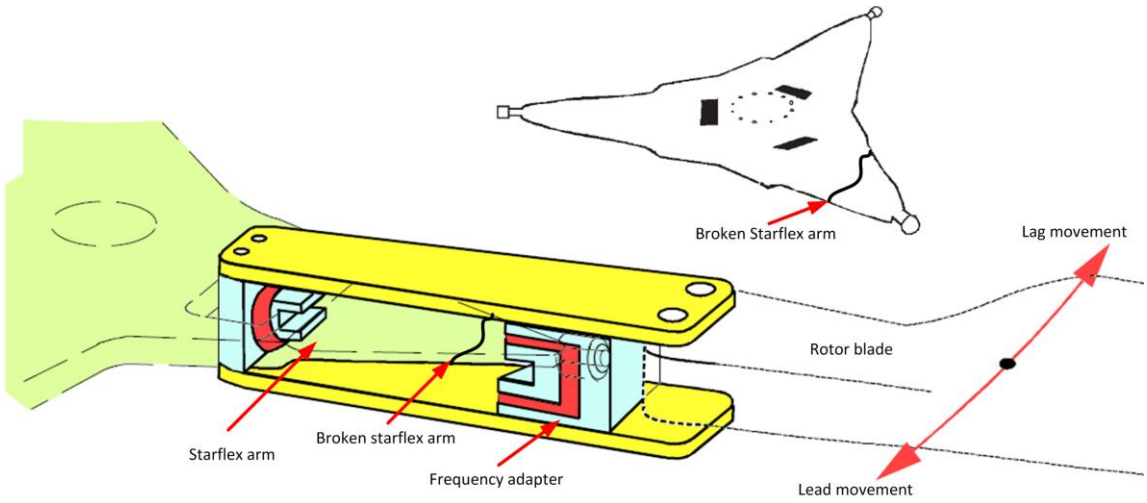


*Figure 10: Effect of broken Starflex arm. Illustration: AIBN/Airbus Helicopters*

2.3.2 Phase 2: The helicopter impacted the water tail first. This caused substantial damage to the helicopter's tail section; the tailboom was nearly torn off. When the main rotor hit the water and stopped abruptly, this caused impact shock which resulted in further damages to the rotor head's Starflex hub, blade sleeves and the rotor blades. The two right hand main gear box suspension bars were torn off, and the main gear box shifted to the right.

[7] See AIBN report 2018/05

## 2.4 Issues on board the yacht

2.4.1 Due to the planned cruise along the Norwegian coast, the user of the yacht and his guests wanted to have a helicopter on board. The helicopter was going to be used for sightseeing flights from the yacht. To be independent from refuelling ashore, a fuel bowser was acquired, and was located forward on the helideck.

2.4.2 A decision was made to have a tarpaulin made to cover the jet fuel bowser when it was not in use. Despite of the tarpaulin being made with eyelets which made it possible to lash it down, this was not done. According to instructions in the Helicopter Operations Manual's checklist describing preparation before helicopter operations all loose items must be secured. Since the tarpaulin fitted tightly around the fuel bowsers frame, it was not regarded as a loose item and it was decided not necessary to secure it in coastal waters. The tarpaulin came on board the day before the accident, the same day as the fuel bowser came on board. The tight fit of the tarpaulin and the fact that both the fuel bowser and the tarpaulin were new to the yacht's crew may have resulted in the tarpaulin not being considered as loose equipment that needed to be lashed down.

2.4.3 The first mate on board was recently hired and had been given a one-day introduction into the yacht's routines. This introduction did not cover routines for helideck operations, except for some advice from his predecessor. The first mate was appointed as the Helicopter Landing Officer (HLO) without being given relevant training.

2.4.4 The yacht had a Helicopter Operations Manual. This manual was not subject to approval by neither maritime authorities nor aviation authorities.

2.4.5 The AIBN finds it positive that a Helicopter Operations Manual existed. At the same time, it appears as if the manual was not in use. The lack of adherence to multiple requirements and procedures indicates that the manual was a passive document. Incomplete preparation of the yacht would have mandated the master's denial of landing the helicopter if the manual's procedures had been followed.

2.4.6 M/Y Bacarella was not in commercial operation. This meant that the yacht was not subject to authority approvals as regards helicopter operations. Thereby, the yacht was not subject to any authority inspections or audits regarding its procedures for helicopter operations. The responsibility for safe operation was placed with the yacht's master and the helicopter's commander.

2.4.7 According to the master, he accepted the wish for landing on the yacht on short notice. This was not sufficient time to set out from the quay, deploy a tender, and to prepare the helideck's fire extinction equipment. However, not adhering to the Helicopter Operations Manual regarding the tender and fire extinguishing equipment were not contributory factors to the accident. Even though the master is responsible for the ship, the wish expressed by those on board the helicopter is believed to have influenced the master's decisions. This assumption is supported by the master's statement that he felt pressed for time to prepare the yacht for the landing.

2.4.8 The AS 350 B3 is standard equipped with an Appareo 1000 video recorder. Both in this accident and in previous accidents investigated by the AIBN, this has proven vital for understanding accidents. This supports former Safety Recommendations (SR's) on making such recorders mandatory for aircraft not equipped with conventional recorders (Flight Data Recorder and Cockpit Voice Recorder).

# 3. CONCLUSION

This accident was caused by the breach of multiple safety barriers. This applies both on board M/Y Bacarella and on the actual flight.

## 3.1 Investigation results

a) The weather was not a factor in this accident.

b) The AIBN has not discovered any technical errors or irregularities in the helicopter that may have influenced the course of events during this accident.

c) The fuel bowser that was loaded on board the yacht the day before the accident was new to the yacht's crew. The yacht's crew did not lash down the tarpaulin that was acquired due to its tight fit around the fuel bowser's frame. It was not considered necessary to do that except in high winds and when in open waters. Main rotor downdraft during landing was obviously not a part of this consideration.

d) The commander had valid British ATPL(H) with type rating for AS 350 B3 and flight instructor privileges.

e) The person piloting the helicopter had a PPL(H), but no type rating for the helicopter type. He had had performed his skill test on AS 350 B3 the day before the accident. It was his first attempt to land an AS 350 B3 on the helideck. Landing on a helideck was not a part of any formal flight training programme. Thus, this was not a flight that formally required an instructor.

f) The limited size and geometry of the helideck called for precise manoeuvring of the helicopter during landing in a ground effect situation that made the helicopter behave differently than over a larger and flat surface.

g) AIBN is of the opinion that the commanders risk assessment of the planned landing on the yacht's helideck was insufficient, taken into consideration new equipment on the helideck, and the flying pilot's minimal experience on the helicopter type.

h) Since the yacht operated on a private basis, there were no authority regulations for operations of helicopters to and from the yacht. The responsibility to ensure safe operation was on the master of the yacht and the commander of the helicopter.

i) Not adhering to multiple procedural requirements in the yacht's Helicopter Operations Manual, together with the fact that procedures for helicopter refueling and operation with AS 350 helicopters were missing, indicated that the document not was in use.

j) The helicopter's approach to the yacht ended up in a hover over the helideck, that lasted for approximately 15 seconds. This allowed the tarpaulin over the fuel bowser to inflate by the pulsating downdraft from the main rotor, and causing it to "creep" upwards on the fuel bowser's frame before it finally blew up and hit the main rotor.

k) The helicopter became uncontrollable when the tarpaulin hit the main rotor disc.

l) The fuel bowser on board was a provisional solution for the planned cruise along the Norwegian coast, and came on board the day before the accident. The objective was to have jet fuel reserves onboard.

m) The tarpaulin for the fuel bowser was made to fit the fuel bowsers frame. This can be the reason why it was not secured, even though it was provisioned with affixed eyelets for lashing. This was not in compliance with the checklist requirements for preparation of helicopter operations in the yacht's Helicopter Operations Manual.

n) The yacht's crew did not properly prepare the ship for the helicopter operation. A tender was not launched, and the fire extinguishing equipment for the helideck was not prepared. However, lack of preparation regarding these issues did not contribute to the accident.

o) M/Y Bacarella's first mate had not received training in his role as "Helicopter Landing Officer" as described in the yacht's Helicopter Operations Manual.

p) One of the Norwegian Society for Sea Rescue's boats was in the immediate vicinity, and life-saving efforts on the passenger who lost consciousness were initiated within a few minutes. These efforts were crucial in saving this person's life.

q) The commander's efforts after the accident had taken place was crucial to prevent the helicopter from sinking with a passenger on board and to prevent drowning of the same.

# 4. SAFETY RECOMMENDATIONS

AIBN does not make any safety recommendations[8] in connection with this investigation.

Accident Investigation Board Norway

Lillestrøm, 11 February 2019

[8] The Ministry of Transport and Communications ensures that safety recommendations are presented to the aviation authorities and/or other relevant ministries for assessment and follow-up, cf. Section 8 of the Regulations relating to public investigation of air traffic accidents and incidents in civil aviation.

# APPENDICES

Appendix A: Abbreviations

# APPENDIX A: ABBREVIATIONS

| | |
|---|---|
| AAIB | Air Accidents Investigation Branch |
| AIBN | Accident Investigation Board Norway |
| ABS | American Bureau of Shipping |
| ATPL(H) | Airline Transport Pilot Licence Helicopter |
| BEA | Bureau d'Enquetes et d'Analyses pour la Sècuritè de l'Aviation Civile |
| CAA | Civil Aviation Authority |
| CAP | CAA Publication |
| CCTV | Closed circuit television |
| CPL(H) | Commercial Pilot Licence Helicopter |
| CPR | Cardiopulmonary Resuscitation |
| EDR | Engine Data Recorder |
| HLA | Helicopter Landing Area |
| HLO | Helideck Landing Officer |
| ICAO | International Civil Aviation Organization |
| ISM | International Safety Management |
| LYC | Large Yacht Code |
| M/Y | Motor Yacht |
| MCA | UK maritime and Coastguard Agency |
| PPL(H) | Private Pilot Licence Helicopter |
| PVC | Polyvinyl chloride |
| RTF | Registered Training Facility |
| USCG | United States Coast Guard |
| UTC | Coordinated Universal Time |
| VHF | Very High Frequency |